BOTANICAL MUSEUM LEAFLETS
HARVARD UNIVERSITY

CAMBRIDGE, MASSACHUSETTS, DECEMBER 27, 1967 VOL. 22, NO. 2

PREHISTORIC MAIZE, TEOSINTE, AND TRIPSACUM FROM TAMAULIPAS, MEXICO

BY

PAUL C. MANGELSDORF, RICHARD S. MACNEISH, AND WALTON C. GALINAT *

IN an earlier paper (Mangelsdorf *et al.*, 1956) we described the prehistoric maize uncovered in archaeological excavations conducted by MacNeish in 1949 in La Perra Cave in the state of Tamaulipas, northeastern Mexico. The earliest of this maize, dated at 2500 B.C. by radiocarbon determinations of associated wood and leaves, was identified as a precursor of a still existing Mexican race Nal-Tel, one of the four Mexican races described by Wellhausen *et al.* (1952) as Ancient Indigenous. We did not regard this maize, although primitive in some characteristics, as wild corn.

While excavating La Perra Cave, which is located in eastern Tamaulipas, MacNeish also made some preliminary soundings in several caves in southwestern Tamaulipas which persuaded him that still earlier corn, perhaps even prehistoric wild corn, might be found in the lower levels of the refuse of these caves. Accordingly in 1954,

* The authors are respectively: Fisher Professor of Natural History, Harvard University; Head Department of Archaeology, University of Calgary, Calgary, Alberta, Canada; Associate Professor, Waltham Field Station, University of Massachusetts, formerly Research Associate, Bussey Institution, Harvard University.

with the assistance of David Kelley, then a graduate student in anthropology at Harvard, he excavated two caves, Romero's and Valenzuela's, and sampled the refuse in a third, Ojo de Agua, all located in Infiernillo Canyon. The earliest corn from these caves proved disappointingly to be not earlier than the La Perra Cave but slightly later, 2300–1800 B.C. It was, however, of a race different from the La Perra corn and showed some resemblance to the early prehistoric corn of Bat Cave in New Mexico described by Mangelsdorf and Smith (1949). We now recognize both as being related to the prehistoric wild corn of Tehuacán Valley described by Mangelsdorf *et al.* (1964).

Of even greater interest was the discovery in the Infiernillo Canyon caves of several specimens each of teosinte, the closest relative of maize, and of Tripsacum, a more distant relative. The prehistoric remains of these three species of the American *Maydeae* are described below, following a brief description of the site and its environs.

Description of the Site

The Canyon Infiernillo is located in southwest Tamaulipas in the northern part of the municipio Ocampo. In terms of our previous investigations in Sierra de Tamaulipas (MacNeish, 1958; Mangelsdorf *et al.*, 1956), this region is about 75 miles to the southwest and has a very different environment. Immediately southwest of the dry Sierra de Tamaulipas at an elevation never over 1500 feet is the wide flat meandering Guayalejo River Valley with a tropical vegetation extending up from the south. West and southwest of this valley lie the first north-south oriented ridges of the Sierra Madre mountains. The lower slopes of these mountains are covered with a tropical, deciduous forest; from 2500 to 4000 feet the vegetation forms a cloud forest; and at higher eleva-

tions a pine-oak forest occurs. Further to the west the valley becomes narrow and the ridges even higher. Covered with pine-oak forests at their summits, these ridges cast "rain shadows" on the bottoms of the valleys which consequently are quite dry and have a xerophytic vegetation in which maguey, cactus, mesquite, and chaparral predominate. Canyon Infiernillo, to which we were guided in 1954 by Don Ignacio Guerra, is one of those dry canyons containing three caves named Romero's, Valenzuela's, and Ojo de Agua. These are all situated high above the canyon floor at the base of limestone cliffs and may have been the mouths of former underground rivers that have since become dry and in part filled in. These relatively deep tunnel-like caves are extremely dry and in prehistoric times would have been ideal places for living. Because of their dryness much of the refuse and remains of the ancient inhabitants has been almost perfectly preserved.

The Stratigraphy

All three caves had stratified occupational layers which not only revealed a long cultural sequence but also yielded many botanical specimens which could be brought to bear upon the problems of early agriculture and subsistence activities.

Radiocarbon determinations and correlations of artifacts with those of other sites permit us to recognize six more or less distinct cultural phases beginning at about 2350 B.C. The characteristics of these phases have been described in detail elsewhere (MacNeish, 1958). Here we need be concerned only with their approximate ages. In sequence beginning with the most recent they are:

San Antonio	A.D. 1450–1800
San Lorenzo	A.D. 1050–1450
Palmillas	A.D. 200–800

Mesa de Guaje	1200–400 B.C.
Guerra	1850–1200 B.C.
Flacco	2350–1850 B.C.

The Specimens

The maize specimens from only one of the three caves, Romero's, have been analyzed in detail but an early cob from the Flacco phase of Valenzuela's Cave has been included in the analysis as well as several specimens of teosinte and *Tripsacum*.

The collection of prehistoric remains of maize and its relatives described here comprises 12,014 specimens and includes virtually all parts of the plant: pieces of stalk, leaves, husks, cobs and cob fragments, tassel and tassel branches. There are a large number of quids of chewed stalks, young ears, and tassels as well as several specimens of teosinte and *Tripsacum*. A brief description of the remains in the several categories follows.

Classification of the Cobs

All of the intact cobs as well as those almost intact were classified on the basis of their resemblance to the existing races of corn in Mexico described by Wellhausen *et al.* (1952). Nine different races or subraces were identified among the prehistoric cobs. Their relative frequency in terms of percentage of total cobs in the several levels of the cave is shown in Table I.

The Chapalote Complex

The great majority of the cobs, about two thirds of the total, were identified as belonging to the race Chapalote or its precursors or derivatives. This race is found today only in western Mexico (Wellhausen *et al.*, 1952) but it was once much more widespread. The prehistoric wild corn uncovered in caves in the valley of Tehuacán

TABLE I. Classification of the Prehistoric Specimens of Maize and Its Relatives Associated with Six Cultural Phases in Caves in Southwestern Tamaulipas.

Classification of Specimens	Cultural Phase						
	San Antonio A.D. 1450–1800	San Lorenzo A.D. 1050–1450	Palmillas A.D. 200–800	Mesa de Gauje 1200–400 B.C.	Guerra 1850–1200 B.C.	Flacco 2350–1850 B.C.	Total Specimens
Cobs							
Pre-Chapalote				2	14	1	17
Early Chapalote	5	2	24	56	46		133
Tripsacoid Chapalote	299	356	457	307	127		1546
Chapalote	108	122	116	25			371
Breve de Padilla	350	279	188	19			836
Palomero Jalisciense	7	15	11	4			37
Harinoso de Ocho	19	10	3				32
Nal-Tel	23	17					40
Tuxpeño		3					3
Unidentified Fragments	229	71	49	53	55		457
Other Maize Parts							
Stalks	13	12	5	11	6		47
Leaves	4	2	2		1		9
Husks	45	60	70	42	2		219
Tassels	6869	904	307	15	4		8099
Quids	44	39	63	5			151
Maize Relatives							
Teosinte			1	7	1		9
Maize-teosinte Hybrids				1	2		3
Tripsacum		1	1		2	1	5
Total Specimens							12,014

in southern Mexico is related to Chapalote (Mangelsdorf *et al.*, 1964) as is also the earliest prehistoric corn from Swallow Cave in Sonora, Mexico (Mangelsdorf and Lister, 1956) and from Bat Cave in New Mexico (Mangelsdorf *et al.*, 1967). Ears, kernels, and cobs of this race have also been identified among the prehistoric specimens from archaeological sites in Arizona, Utah, Colorado, Nebraska, Oklahoma, and Texas. This race, originating from its wild progenitor in southern Mexico, spread through western and northwestern Mexico and from there throughout the region now the southwestern United States. It has not been found, however, either archaeologically or among existing races, in lowland eastern Mexico. There the earliest corn is Nal-Tel, a race closely related to Chapalote and perhaps stemming from it. Nal-Tel is found today in Yucatan and Campeche and sporadically in Oaxaca and Guerrero. One collection of this race has been made in San Luis Potosi (Wellhausen *et al.*, 1952). The chief difference between these two ancient races is in pericarp color, Chapalote having brown and Nal-Tel orange pericarp. Other differences include shape of the ear and hairiness of the cupules. Although the differences are not consistent, Chapalote tends to have a longer, more tapering, cob than Nal-Tel and to have cupules which are less hairy.

The fact that Chapalote is the predominating race in the prehistoric cobs from Canyon Infiernillo caves while the early corn from La Perra Cave is exclusively Nal-Tel (Mangelsdorf *et al.*, 1956) suggests that races of cultivated maize, like other artifacts, are characteristic of the cultures to which they belong. The people who occupied La Perra Cave were evidently related to lowland agriculturists of eastern Mexico while those of the Canyon Infiernillo caves had their affinities westward and northward (MacNeish, 1958). It would also appear that races

of maize, although clearly related to each other such as Chapalote and Nal-Tel, had early become adapted to different highland and lowland environments and tended to spread within these "ecological zones." This in turn suggests that perhaps it was only at the latest prehistoric levels that the culture and agriculture of the highlands and lowlands merged to become the single "culture area" Meso-America.

Pre-Chapalote. (Plate VIII, A). Following the nomenclature employed in our earlier descriptions of prehistoric maize (Mangelsdorf *et al.*, 1956; Mangelsdorf and Lister, 1956) we have called the earliest corn uncovered in Romero's Cave Pre-Chapalote. The cobs of this subrace have the same tapering shape as those of the modern Chapalote but are much smaller. None are as small, however, as the prehistoric wild corn from Tehuacán Valley. We assume that even the earliest corn from the Tamaulipas caves is cultivated corn.

Pre-Chapalote makes its first appearance (a single cob) in the Flacco phase of Valenzuela's Cave dated at 2350–1850 B.C. It appears last in the Mesa de Guaje phase dated at 1200–400 B.C. The total number of cobs of this subrace is 17.

Early Chapalote. (Plate VIII, A). The cobs of this subrace, comprising 133 specimens, are intermediate in size between those of Pre-Chapalote and modern Chapalote. In other respects the cobs are quite similar to those of modern Chapalote. Cobs of this subrace appeared first in the Guerra phase dated at 1850–1200 B.C. and last in the San Lorenzo phase, A.D. 1050–1450.

Tripsacoid Chapalote. (Plate XI, A). Slightly more than half of all identified cobs, 1546 specimens, were assigned to a subrace which we called Tripsacoid Chapalote. The cobs are quite similar to those of Chapalote but differ in the induration of their tissues, especially of

the rachises and glumes which are highly indurated. Cobs of this race are probably the product of hybridization of Chapalote with corn's closest relative, teosinte. Specimens of teosinte and corn-teosinte hybrids were found among the prehistoric vegetal remains.

The Tripsacoid Chapalote appeared first in the Guerra phase but at a later level than the Early Chapalote. A single cob occurred in level 5 and the subrace was well established (126 cobs) in level 4b which represents the end of the Guerra phase probably about 1500–1200 B.C. This corn became the predominating type in the two succeeding phases, 1200 B.C.–A.D. 800, and thereafter was gradually replaced by other races, persisting, however, as a prominent component in the complex until A.D. 1800, after the arrival of the Spaniards.

Chapalote. (Plate VIII, B). Cobs of a type quite similar to those of modern Chapalote appeared first in the Mesa de Guaje phase, 1200–400 B.C. They increased in frequency in the Palmillas phase (14.5 percent of all cobs) and continued to maintain approximately this frequency until the end of the series. A total of 361 cobs were assigned to this category.

Wellhausen *et al.* (1952) collected modern Chapalote in only two states in Mexico, Sinaloa and Sonora, but as pointed out above it must at one time have been much more widespread.

Breve de Padilla. (Plate X, A). Making its first appearance only slightly later than modern Chapalote—level 4a of the Mesa de Guaje phase—is a race called Breve de Padilla by Wellhausen (unpublished).

The origin of this race is not definitely known. Its cobs are longer and thicker than those of Chapalote and it may be the product of hybridization between Chapalote and Harinoso de Ocho, a race originally from South America and still found sporadically in western Mexico.

Not altogether consistent with this suggestion is the fact that Breve de Padilla, the suspected hybrid, appears before Harinoso de Ocho, the putative parent. However, the former occurs first in the upper level of the Mesa de Guaje phase, the latter in the lower level of Palmillas, the succeeding phase. Also, the Harinoso de Ocho had so low a frequency at all levels that its absence in the Mesa de Guaje phase may represent nothing more than a sampling error.

Whatever its origin, Breve de Padilla appears to have been a productive race which rapidly replaced other races. Starting with an initial frequency of 4.6 percent, the cobs of this race increased in succeeding phases to 23.5, 35.1, and 43.1 percent. In the San Antonio phase, A.D. 1450–1800, this was the predominating race. Altogether 836 cobs were assigned to this race.

Cobs identified as those of Breve de Padilla had previously been found among the later prehistoric specimens uncovered in the Sierra de Tamaulipas caves (Mangelsdorf *et al.*, 1956; MacNeish, 1958) but their frequency was low. This may be regarded as a further bit of evidence that this race is western in origin and that La Perra and Canyon Infiernillo caves represent different peoples with respect to their agriculture.

Minor Races

A total of 112 cobs were found which could not be assigned to any of the races described above but all seemed to be related to others of the existing races described by Wellhausen *et al.* (1952). The following races were identified among the cobs.

Harinoso de Ocho. (Plate XI, B). As already mentioned Harinoso de Ocho first appeared in the lower level of the Palmillas phase, A.D. 200–850. At no time, however, did it attain a high frequency and the total num-

ber of cobs assigned to this race was only 32, about one percent of the total identified cobs.

Although not common in Mexico today, Harinoso is important as one of the progenitors of a number of races. According to Wellhausen *et al.* (1952) Harinoso de Ocho has given rise directly to the widely grown race Tablon-cillo and indirectly to Jala, Bolita, Celaya, and Cónico Norteño and is also related to Olotillo of southwestern Mexico. Evidence presented by Galinat and Gunnerson (1963) indicates that Harinoso de Ocho is the progenitor of the eight-rowed flour corn of the upper Mississippi and the eight-rowed flint corn of New England. This in turn makes it one of the ancestors of Corn Belt dent corn of the United States. It may also be, as suggested above, one of the progenitors of Breve de Padilla which became the predominating race of Romero's Cave between A.D. 1450–1800.

Nal-Tel. (Plate X, B). A total of 40 cobs were assigned to the race Nal-Tel which is the eastern lowland counterpart of Chapalote and was the predominating race in La Perra Cave in eastern Tamaulipas. Its low frequency in Infiernillo Canyon compared to the high frequency of Chapalote indicates that there was little interchange of cultivated corn varieties between the peoples represented by these two caves which are physically only about 75 miles apart.

Palomero Jalisciense. (Plate IX, B). A total of 37 cobs were assigned to this race which is described by Wellhausen *et al.*(1952) as a subrace of Palomero Toluqueño, one of the Ancient Indigenous races of Mexico. The subrace differs from the ancestral race in having thicker cobs and a higher kernel-row number. Among the living races of Mexico, it has been collected only in southern Jalisco at elevations of 2600 to 2700 meters. In comparison to Palomero Toluqueño, it is slightly

more vigorous, has a stronger root system, and is later in maturity. Also the ears are somewhat less tapering than those of Palomero Toluqueño. Wellhausen *et al.* (1952) suggested that these modifications had probably been brought about through introgression of Olotón, a race common in the high altitudes of the state of Chiapas, Mexico, and in Guatemala.

Tuxpeño. (Plate XI, A). Three unusually large cobs occurred which showed some resemblance to Tuxpeño, the predominating modern race of the lowlands of eastern Mexico. There is some question, however, whether these cobs are actually of this race. A combination of higher than average hybrid vigor and better than average growing conditions could have produced unusually large cobs of the race Breve de Padilla, which could be confused with cobs of Tuxpeño. On the other hand, it is possible that Tuxpeño, which occurs in this part of Tamaulipas today, reached there in prehistoric times and it is to avoid overlooking this possibility that we include here a specific mention of these three large cobs.

Other Parts of the Corn Plant

A total of 8525 specimens of other parts of the corn plant were identified. These included stalks, leaves, husks, tassels, and chewed quids.

Stalks

Like the cobs, the pieces of stalks, 47 in number, showed an evolutionary sequence with respect to size, the earlier ones being on the average more slender than the later.

Leaves

Nine leaves or leaf fragments among the specimens add no significant information since they are similar to the leaves of modern corn.

Husks

Like the cobs and stalks, the husks, a total of 219 pieces, showed an evolutionary sequence with respect to size, the earlier ones being on the average shorter than the later ones.

Tassels

An amazingly large number of tassels, tassel branches, and tassel fragments, 8099 specimens in all, were found among the vegetal remains. There is great variation among these; the later ones are indistinguishable from those of modern races of corn; some of the earlier ones have smaller spikelets. Although some students of maize (Anderson and Cutler, 1942) consider the tassel to be an especially useful organ in classifying maize, we have not yet been able to discover any clear-cut, diagnostic characters which will allow us to assign the tassels, as we have the cobs, to recognized races. We are, however, preserving all the specimens of tassels in the hope that some future student of prehistoric maize may see in them more than we have so far been able to discern.

The most puzzling aspects of the tassels is why they should have been preserved at all. Perhaps young tassels still containing their anthers served as a source of food. The ancient peoples who occupied this cave seem to have led a precarious existence with respect to their food supply and they chewed, presumably for the sugar they contained, a great variety of plants and plant parts. One of the specimens among the quids is undoubtedly that of the chewed young tassel since partly chewed staminate glumes can be identified in it. Also, we now know that corn pollen is rich not only in a number of amino acids but also in vitamins and minerals. Anthers filled with ripe pollen may be veritable little vitamin-mineral capsules and may have supplied some much needed elements to the diet. However, the majority of the prehistoric

tassel branches are those of matured tassels that have shed their pollen and lost their anthers. We can think of no use to which they might have been put for food or any other purpose except possibly a primitive ceremonial one.

Chewed Quids

The refuse contained a large number of chewed quids some of which, a total of 151, were identified as those of corn. Quids composed of chewed tassels have already been mentioned. Two other types were recognized: those produced by chewing young ears enclosed in husks and those resulting from chewing stalks. Both were probably chewed more for their sweetness than for the few calories which they added to a none-too-adequate diet. After identifying two partly chewed young ears in the refuse of La Perra Cave some years ago, we chewed their modern counterparts and found them sweet.

The majority of quids were those of chewed stalks. Chewing evidently began at one end of a piece of stalk and continued until the entire piece was thoroughly masticated and only the fiber remained. The process must sometimes have been interrupted for a few of the quids had unchewed sections of the stalk still attached producing a quid with a stem, a structure somewhat reminiscent of a modern lollypop (Plate XIII, D).

The chewing of both stalks and young ears must have been at the expense of subsequent grain production. Perhaps in this stage of culture being provident had not yet become a virtue and was seldom practiced.

Teosinte

We identified nine specimens of teosinte and three of maize-teosinte hybrids. The earliest specimen, a fragment of fruit case, occurred in feces in one of the lower levels of the Guerra phase dated at 1850–1200 B.C.

Other specimens occurred in the two succeeding phases. Several of these comprised clusters of spikes (Plate XII, A).

The specimens which we identified as maize-teosinte hybrids differed from those of teosinte in having thicker stalks and non-fragile rachises. The one illustrated in Plate XII, B is of particular interest in resembling spikes which we have produced by introducing one of the tunicate alleles into teosinte thereby replacing the highly indurated lower glume of teosinte with the herbaceous glume of tunicate maize. When we first encountered this specimen we wondered briefly whether it might represent the ancestral form of corn postulated by the late R. A. Emerson: a soft-shelled form of teosinte.* Because these specimens were borne on thicker stalks than the clusters of teosinte we concluded that they were maize-teosinte hybrids.

We cannot be certain whether the specimens identified as maize-teosinte hybrids are F_1 hybrids or segregates appearing in subsequent generations. They resemble F_1 hybrids in their non-shattering rachises but differ from typical modern F_1 hybrids in having single rather than paired spikelets.

The presence in the caves of remains of teosinte is puzzling. The seeds of teosinte are nutritious, having a higher protein content than those of corn (Melhus *et al.*, 1953), but are enclosed in hard bony shells from which they are difficult to remove. Although this can be done by popping if the moisture content of the seeds is right (Beadle, 1939) there is no evidence from the prehistoric remains that teosinte was used in this way. On the contrary Dr. E. O. Callen, who has made a study of the feces from these caves, has found a number of teosinte fruits with their hard bony shells still undamaged or un-

* In conversation.

changed. Since it is unlikely that the consumption of intact teosinte fruits provides any satisfaction or nutritional benefit to the consumer, there must have been some other reason for their use. Hernandez states that teosinte seeds are a cure for dysentery (Wilkes, 1967) and although it is doubtful that this is true, the inhabitants of the Infiernillo Canyon caves may well have believed it to be. Or did the Indians of this region perhaps practice the custom of planting teosinte in their corn fields to improve the corn as did those of western Mexico (Lumholz, 1902) or those of some parts of Guatemala (Melhus and Chamberlain, 1953)? The prehistoric specimens do not distinguish between the two possibilities. The finding of several fruits in a leather container in a pit extending down from a Palmillas floor suggests only that the fruits were regarded as having some value. The occurrence of maize-teosinte hybrids suggests that teosinte grew in or near the corn fields in prehistoric times although it is unknown in Tamaulipas today.

The early occurrence in this site of teosinte and of tripsacoid maize, presumably the product of teosinte introgression, may raise questions regarding the hypothesis of Mangelsdorf and Reeves (1939, 1959) that teosinte is a hybrid of maize and *Tripsacum* which may have occurred after the cultivation of maize began. There is still earlier evidence of tripsacoid maize, although not of either teosinte or *Tripsacum*, in the prehistoric cobs from caves in the valley of Tehuacán. In these sites, the tripsacoid corn first appeared as a single cob in the Abejas phase, 3400–2300 B.C., and had become well established in the later Ajalpan phase, 1500–900 B.C. The earliest corn in both Tehuacán Valley and in Tamaulipas is non-tripsacoid corn. The tripsacoid corn appears soon afterward and in Romero's Cave at the same level as teosinte. These several findings, although consistent with the hy-

pothesis of the hybrid origin of teosinte, by no means prove its validity.

Tripsacum

Slightly less puzzling, since it still grows in Tamaulipas, is the presence of *Tripsacum* in the refuse of the Canyon Infiernillo caves. Seeds of *Tripsacum*, like those of teosinte, are nutritious but are difficult to remove from the bony shells in which they are enclosed. They are not especially promising as a source of food yet must sometimes have been gathered for this purpose. Gilmore (1931) found fruits of *Tripsacum* in the prehistoric refuse of a cave in the Ozarks.

Five specimens of *Tripsacum* were found in the refuse and these included both staminate and pistillate spikelets (Plate XIII, B). We were not able to make positive identification with respect to species although one of the spikes seemed to bear a somewhat closer resemblance to *T. zopilotense*—which has not been collected in Tamaulipas—than to *T. dactyloides* which occurs there now.

Summary

1. The vegetal remains uncovered in the refuse in three once inhabited caves in southwestern Tamaulipas, Mexico, are of particular interest in containing specimens of all three of the American Maydeae: maize, teosinte, and *Tripsacum* as well as hybrids of maize and teosinte.

2. The collection, comprising 12,014 specimens, included virtually all parts of the maize plant: stalks, leaves, husks, cobs, and tassels as well as chewed quids of various parts.

3. The corn is predominantly of the race Chapalote; about two thirds of all of the identified cobs are assigned to this race and its several subraces.

4. The predominance of Chapalote and its subraces suggests that the prehistoric corn and the agriculture which they represent have stemmed directly from southern Mexico where the wild corn with which domestication began was identified as a progenitor of the still existing Mexican race Chapalote.

5. Beginning at about 1850–1450 B.C. there is evidence of the introgression of teosinte into corn. More than half of the identified cobs were classified as Tripsacoid Chapalote.

6. Several specimens of maize-teosinte hybrids furnish direct evidence of the hybridization of maize and teosinte.

7. A new race, Breve de Padilla, which became the predominating race in the last phase, A.D. 1450–1800, may be a hybrid of Chapalote with the western Mexico race Harinoso de Ocho.

LITERATURE CITED

Anderson, E. and H. C. Cutler. 1942. Races of *Zea Mays:* I. Their recognition and classification. Ann. Mo. Bot. Gard. 29: 69–88.

Beadle, G. W. 1939. Teosinte and the origin of maize. Jour. Hered. 30: 245–247.

Galinat, W. C. and J. H. Gunnerson. 1963. Spread of eight-rowed maize from the prehistoric Southwest. Bot. Mus. Leafl. Harvard Univ. 20: 117–160.

Gilmore, M. R. 1931. Vegetal remains of the Ozark Bluff-Dweller culture. Mich. Acad. Sci. Arts and Letters 14: 83–102.

Lumholtz, C. 1902. Unknown Mexico. Charles Scribner's Sons, New York.

MacNeish, Richard S. 1958. Preliminary archaeological investigations in the Sierra de Tamaulipas, Mexico. Trans. Amer. Philos. Soc. 48: Part 6.

Mangelsdorf, P. C., H. W. Dick and J. Cámara-Hernández. 1967. Bat Cave revisited. Bot. Mus. Leafl. Harvard Univ. 22: 1–32.

——— and R. H. Lister. 1956. Archaeological evidence on the evolution of maize in northwestern Mexico. Bot. Mus. Leafl. Harvard Univ. 17: 151–178.

———, R. S. MacNeish and W. C. Galinat. 1956. Archaeological evidence on the diffusion and evolution of maize in northeastern Mexico. Bot. Mus. Leafl. Harvard Univ. 17: 125–150.

———, R. S. MacNeish and W. C. Galinat. 1964. Domestication of corn. Science 143: 538–545.

——— and R. G. Reeves. 1939. The origin of Indian corn and its relatives. Texas Agr. Exp. Sta. Bull. 574.

——— and R. G. Reeves. 1959. The origin of corn. III. Modern races, the product of teosinte introgression. Bot. Mus. Leafl. Harvard Univ. 18: 389–411.

—— and C. E. Smith. 1949. New archaeological evidence on evolution of maize. Bot. Mus. Leafl. Harvard Univ. 13: 213–247.

Melhus, I. E., F. Aguirre and N. S. Scrimshaw. 1953. Observations on the nutritive value of teosinte. Science 117: 34–35.

—— and I. M. Chamberlain. 1953. A preliminary study of teosinte in its region of origin. Iowa State Coll. Jour. Sci. 28: 139–164.

Wellhausen, E. J., L. M. Roberts and E. Hernandez X. *in collaboration with* P. C. Mangelsdorf. 1952. Races of maize in Mexico. Bussey Institution, Harvard Univ.

Wilkes, H. G. 1967. Teosinte: the closest relative of maize. Bussey Institution, Harvard Univ.

PLATE VIII. A. The two cobs (left) of Pre-Chapalote; the lower from Guerra phase, 1850–1200 B.C., the upper from the Mesa de Guaje phase, 1200–400 B.C. The remaining four cobs are Early Chapalote. Both types are characterized by relatively soft glumes and rachis tissues. Actual size. B. Typical cobs of the race Chapalote from the Palmillas phase, A.D. 200–800. The stick inserted in one of the cobs may have served as a handle for holding the ear near fire to toast the kernels. Actual size.

Plate VIII

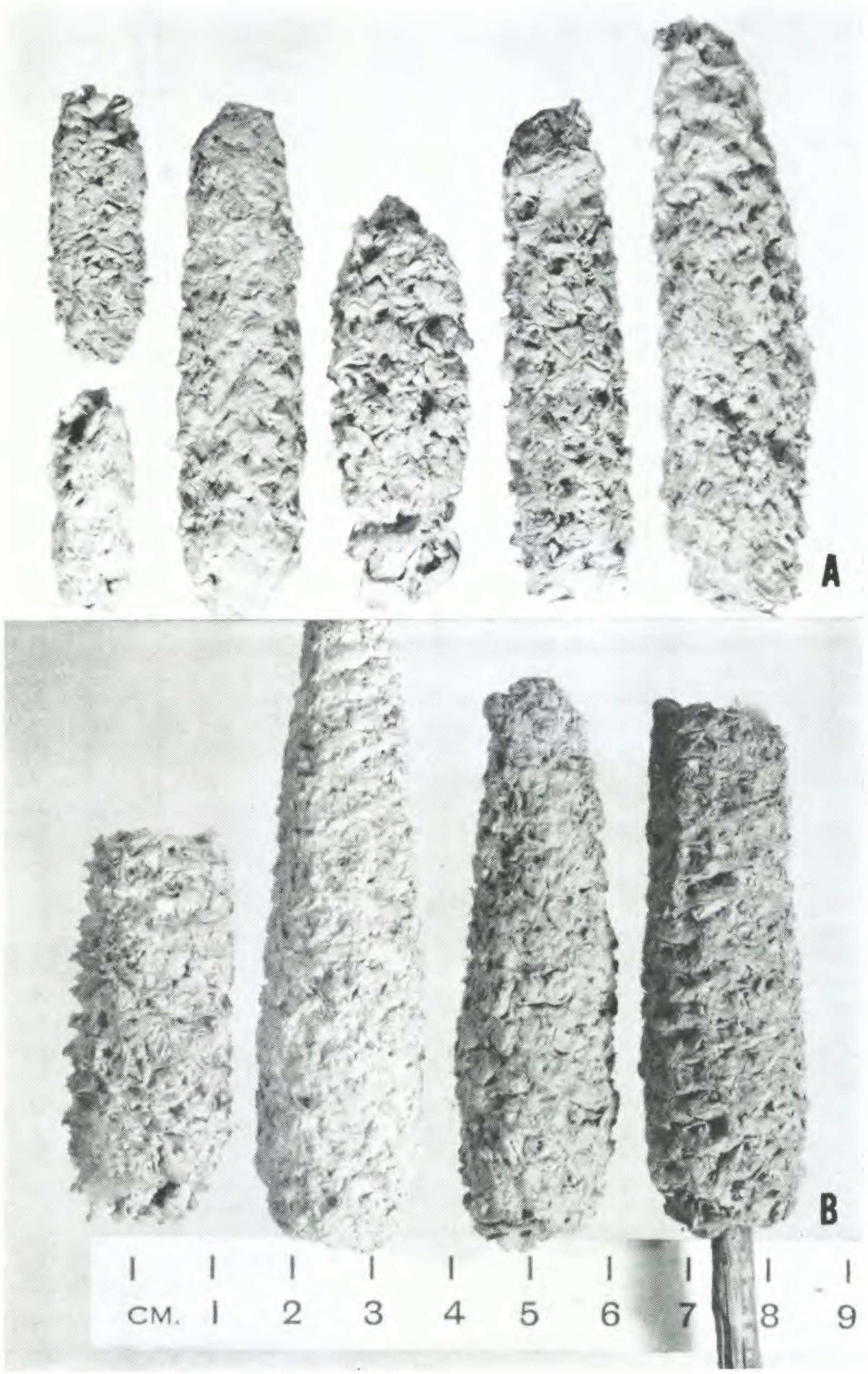
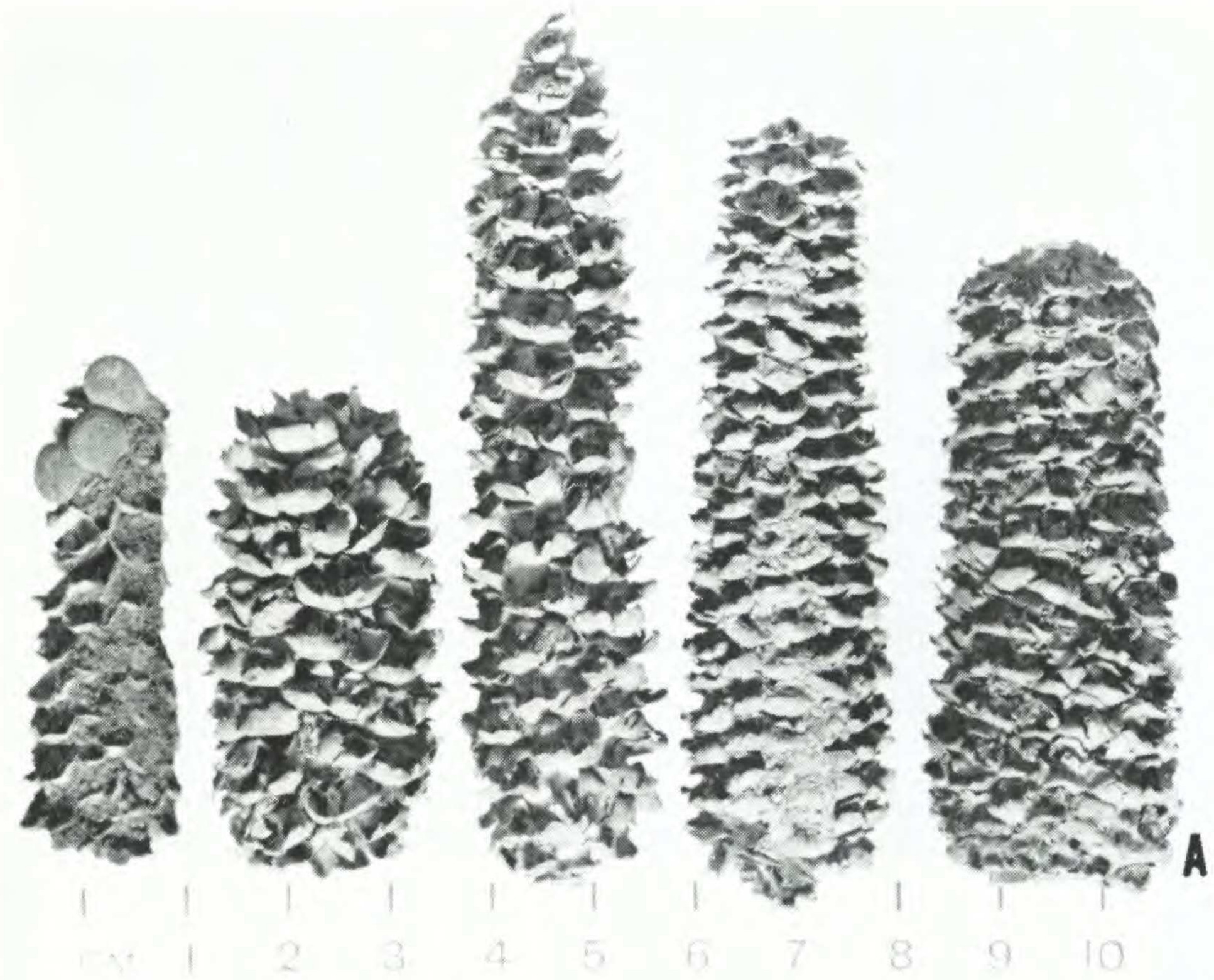
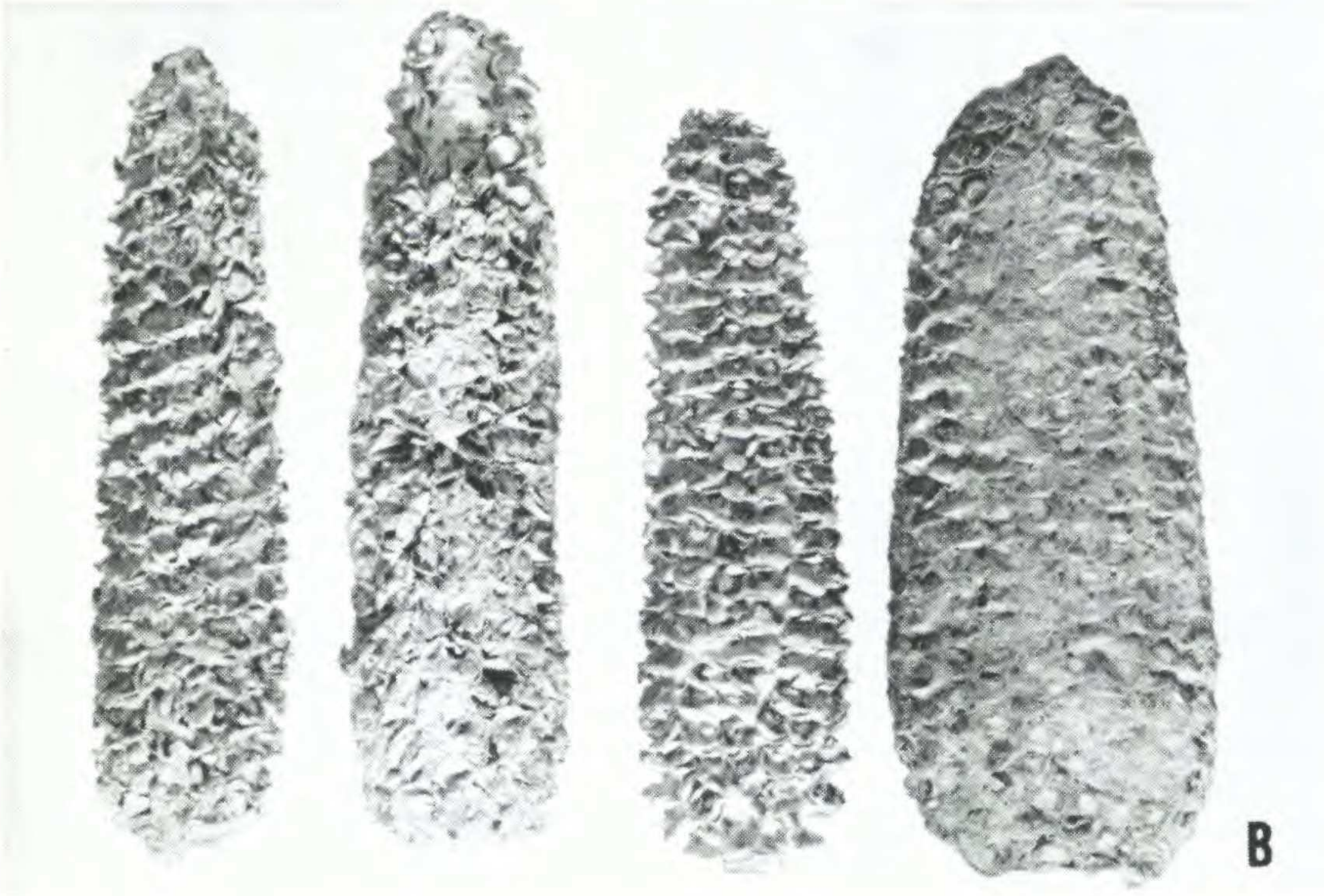
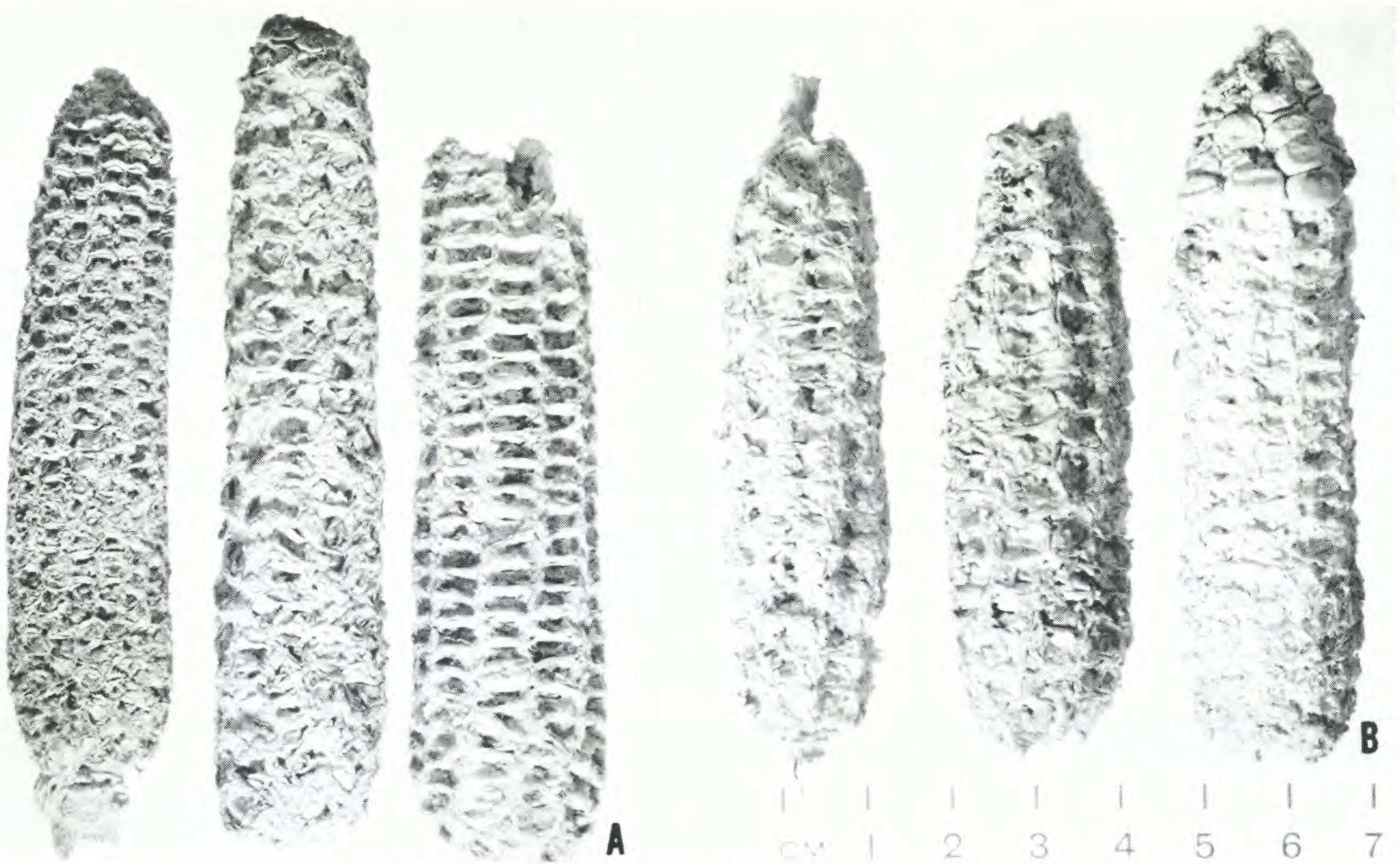


PLATE IX. A. Cobs of Tripsacoid Chapalote from the upper level of the Guerra phase, *ca.* 1400–1200 B.C. This maize, the predominating type in the cave, has indurated tissues of the rachises and lower glumes. When the other floral parts are lost the cobs with their stiff, often curved, lower glumes resemble a coarse file or rasp. The specimen at left still bears three kernels which have the brown pericarp color and round shape characteristic of Chapalote. Actual size. B. Cobs of Palomero Jalisciense, a popcorn race related to Palomero Toluqueño, one of the four Ancient Indigenous races of Mexico. Palomero Jalisciense is known today only in the state of Jalisco. Actual size.

Plate IX







A. Second in frequency are the cobs of Breve de Padilla a race which may be the product of hybridizing Chapalote and Harinoso de Ocho. The latter from western Mexico has participated in the ancestry of a number of modern races including Tabloncillo and Jala in Mexico, and New England flint and Corn Belt dent in the United States. B. Cobs identified as belonging to the race Nal Tel which is the counterpart of Chapalote in the lowlands of eastern Mexico. This race, the predominating one in La Perra Cave in eastern Tamaulipas, was rare in Romero's Cave indicating that there was little interchange of corn varieties between the cultures represented by the two caves. Actual size.

PLATE XI. A. These cobs, of which there were only three, appeared in the San Lorenzo phase, A.D. 1050–1450. They are similar in their characteristics to those of the race Tuxpeño, one of the most productive of the modern races of Mexico, but they may be unusually large cobs of Breve de Padilla, the predominating race in the upper levels of the refuse. Actual size. B. These cobs may be of the race Harinoso de Ocho which is postulated to be the putative ancestor of Breve de Padilla, illustrated in Plate X, and of several other productive races.

Plate XI

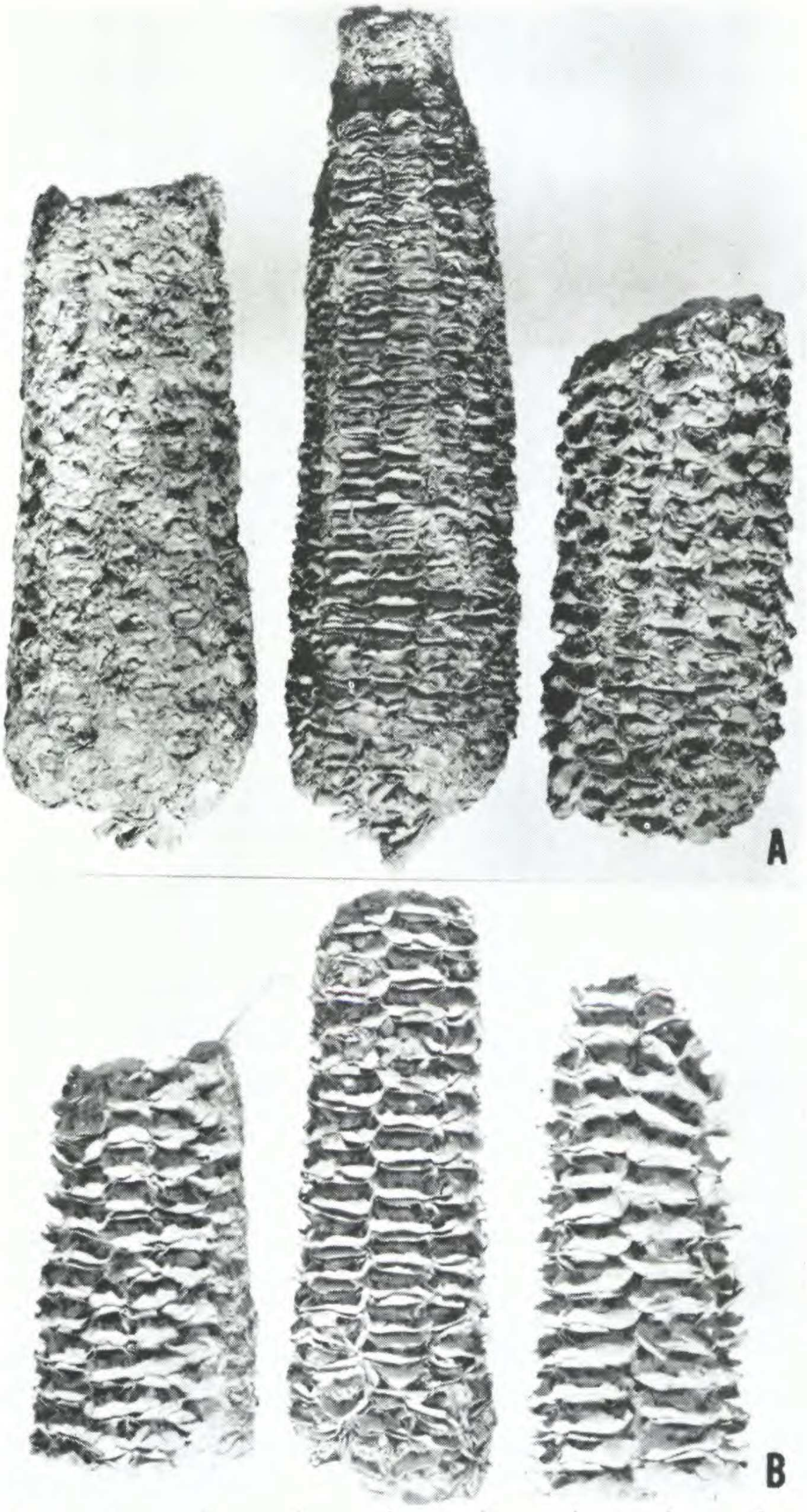


Plate XII

A. A cluster of teosinte spikes with a number of the fruits exposed to view. These, like the fruits of modern Mexican teosinte, are triangular in shape and in this respect differ from the fruits of Guatemalan teosinte which are trapzoidal. B. A spike identified as that of a maize-teosinte hybrid. This differs from spikes of teosinte in having a solid rachis and herbaceous, instead of indurated, lower glumes. Note that the stalk on which it is borne is thicker than the stalks of teosinte shown in Plate XII, A. Actual size.

PLATE XIII. A. Tassel branches from the San Antonio phase, A.D. 1450–1800. All specimens are similar in their botanical characteristics to the staminate tassel branches of modern corn where the spikelets occur in pairs, one member sessile, the other pedicelled. Actual size. B. The pistillate part of a prehistoric spike of *Tripsacum* and the staminate part of another spike. Why *Tripsacum* should have been collected and preserved in the cave is puzzling. Actual size. C. Some of the cobs of Tripsacoid Chapalote are fragile like the spikes of teosinte and break up into disc-like segments (left) which resemble closely the segments of some derivatives of modern maize-teosinte hybrids (right). These prehistoric specimens furnish indirect evidence of the hybridizstion of maize and teosinte. Direct evidence of such hybridization is provided by the maize-teosinte hybrids illustrated in Plate XII, B. D. Quids, the product of chewing tassels (left, center) and a stalk (right). Young ears enclosed in husks were also sometimes chewed. Actual size.

Plate XIII